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INDIRECT REPAIR OF METAL-CERAMIC RESTORATIONS: THE BONDING ISSUE

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ABSTRACT

This work describes the resolution of three clinical situations where the ceramic component of metal-ceramic restorations has fractured. The repair can be done using a direct or an indirect technic, however the last one has better, more stable and predictable results. The different fractures, repaired using indirect technics, are presented and discussed in terms of designs, materials and resin cements.

***Keywords*:** biomechanics, bridges, ceramic fractures, ceramic repair, indirect, veneers, ceramics.

INTRODUCTION

Extensive fixed metal-ceramic oral rehabilitation may present some problems when changes, corrections or repairs are needed over time.

Fracture of the ceramic component (feldspathic mostly) is relatively frequent (2,3 to 8%) due to its low-tension resistance (Haselton, 2001; Latta, 2000; Libby, 1997; Ozcan, 2003; Strub, 1988). After 10 years of use, Coornaert and col., describe higher values of fracture, 5 to 10% (Coornaert, 1984). It is the second major cause that leads to substitution of fixed metal-ceramic rehabilitations after dental caries (Latta, 2000). These situations constitute a functional and an aesthetic problem, especially when the anterior area is affected. Meanwhile, the different physical characteristics of the materials involved (metal and ceramic) allow different possibilities of failure (Ozcan, 2003).

The best solution, most of the times, would be to remove the restoration, but this might present risks to the abutments and to the integrity of the rehabilitation (Galiatsatos, 2005). In case of fracture, when the remaining structure does not present any other problem, it is desirable and possible to maintain it. There are lots of systems, technics and approaches to repair the ceramic with a direct composite restoration (Appeldoorn, 1993; Bertolotti, 1989; Della Bona, 1995; Kupiec, 1996; Pratt, 1989; Shahverdi, 1998; Stangel, 1987). These systems offer a fast, technically simple and cheap option. However, it is often difficult to get an acceptable result because of the difficulty to match the colour and texture of the ceramic surface. Also, in the long term, this alternative presents a high failure rate especially if high occlusal forces are present (Barreto, 1982; Cardoso, 1994; Helpin, 1982; Hirschfeld, 1991).

When the problem in a metal-ceramic bridge does not allow a satisfactory repair through a direct method or it failed in previous attempts, the use of indirect technics can be an alternative. Veneers or partial crowns can be integrated on the fractured structure, but it is a more complex procedure. It constitutes a more aesthetic and stable solution in a long term than a direct repair (Bruggers, 1979; Dent, 1979; Quarnstrom, 2003; Welsh, 1997). On the other hand it is still more confortable, easier and cheaper than replacing all the structure.

Indirect repair methods consist on preparing the affected area, producing a new structure and placing it overlaying the bridge (Bruggers, 1979; Dent, 1979; Quarnstrom, 2003; Welsh, 1997). There can be differences in the design and the materials involved (like metal, feldspathic ceramic, zirconia, lithium disilicate and others); therefore there are issues related to which materials and which cements or bonding agents are the best choices.

Occlusal evaluation is important, since strong occlusal guides, interferences, deep vertical over-biting and parafunctional habits may contraindicate this technic (Quarnstrom, 2003).

OBJECTIVE

The objective of this work is to present and discuss different options in terms of ceramic systems and bonding materials.

MATERIAL AND METHODS

Three cases are presented where the ceramic component of fixed metal-ceramic rehabilitation showed a fracture. As first approach, the repair was made using a direct technic with composite, but eventually leaded to failure. Then indirect methods were used. Analysis of extension and occlusal involvement of the fracture was done first. Different designs and preparations were chosen, involving distinct materials (metal and ceramic) and resin cements (adhesive, non-adhesive and auto-adhesive).

Case 1

A 27-year-old female suffered a ceramic fracture on the tooth 11. This tooth was one of the abutments of a maxillary metal-ceramic bridge of 9 elements (from tooth 17 to 23) placed 4 years before. The fracture encompassed the vestibular-distal-incisal area of the tooth without damaging the opaque ceramic (cohesive fracture). After an oclusal evaluation, it was observed that the affected area was not involved on the protrusion and lateral guides and that the overbite and overjet were not marked. Thus, a direct technic was at first chosen, etching with 9,6% hydrofluoric acid (*Porcelain Etch Gel; Pulpdente Corporation, Watertown, USA*), silanization (*Monobond Plus; Ivoclar Vivadent, Schaan, Liechtenstein*), bonding (*Heliobond; Ivoclar Vivadent, Schaan, Liechtenstein*) and restoration with a composite material (*Filtek Supreme XT; 3M ESPE, St. Paul MN, USA*), as it is shown in Fig.1. Despite of the acceptable aesthetic result, the material fractured several weeks after. A second attempt was performed, but also lead to failure.

Therefore, we chose to prepare the vestibular surface of the abutment (Fig.2) in order to do a ceramic veneer *(emax-press; Ivoclar Vivadent, Schaan, Liechtenstein)*. The

thickness required to this procedure was obtained, preserving the majority of the opaque ceramic over the metallic infrastructure of the bridge. Impression was made with a double mix technic using addition silicone (*Express light Body; 3M ESPE, St. Paul MN, USA* and *Express Penta H Putty Soft; 3M ESPE, St. Paul MN, USA*), followed by provisionally composite veneer (*Filtek Supreme XT; 3M ESPE, St. Paul MN, USA*), as it is shown in Fig.3.

Since the prepared surface of the abutment was mainly ceramic (feldspathic), we chose to bond the veneer (reinforced lithium disilicate ceramic) with a non-adhesive resin (*Variolink II; Ivoclar Vivadent, Schaan, Liechtenstein*) using the following protocol:

- Selection of the colour using the "try-in" system (*Variolink II; Ivoclar Vivadent, Schaan, Liechtenstein*);
- Etching of the ceramic surface of the bridge with 9,6% hydrofluoric acid (*Porcelain Etch Gel; Pulpdent Corporation, Watertown, USA*) during 2 minutes, wash and dry;
- Etching of the veneer inner surface with 9,6% hydrofluoric acid (*Porcelain Etch Gel; Pulpdent Corporation, Watertown, USA*) during 20 seconds, cleaning with 37% phosphoric acid (*Total Etch; Ivoclar Vivadent, Schaan, Liechtenstein*), alcohol wash and dry;
- Silanization of both surfaces during 1 minute (*Monobond Plus; Ivoclar Vivadent, Schaan, Liechtenstein*);
- Adhesive application *(Heliobond; Ivoclar Vivadent, Schaan, Liechtenstein)* on both surfaces, followed by photopolymerization (*Elipar™ S10 3M ESPE*) of the surface of the bridge only (do not photopolymerize the inner surface of the veneer, that must be light protected);
- Preparation and placement of the resin (*Variolink II; Ivoclar Vivadent, Schaan, Liechtenstein*) on the veneer;
- Sitting of the veneer with digital pressure, pre-photopolymerization for 5 seconds, excess removal and final photopolymerization for 10 seconds.

Twenty-four months later the situation still remained stable (Fig.4).

Fig.1 Restoration with a composite material

Fig. 2 Preparation

Fig.3 Provisionally composite veneer

Fig.4 Control after twenty-four months

Case 2

A 58-year-old male suffered a ceramic fracture on the area of tooth 11. This element was one of the pontics of a maxillary metal-ceramic bridge of 10 elements (from tooth 15 to 25) placed 4 years before. The fracture exposed the metallic infrastructure and encompassed the vestibular-mesial surface and incisal edge of the tooth. A direct technic was at first chosen restoring with composite (*SynergD6; Colténe Whaledent,Altstatten, Switzerland*) yielding a good result (Fig.5). However one year later a new fracture of the ceramic and composite occurred. Nevertheless, a new attempt to restore directly with composite was preformed, but the result was not satisfactory in terms of colour match. So a preparation was done in order to restore the pontic using an indirect technic (Fig.6).

Since the fracture had an involvement of the incisal edge, it was extense and presented a reduced thickness of vestibular-palatal ceramic to do a veneer, the preparation was done to do a partial crown. Also, we suspected that the main cause that leaded to ceramic fracture was due to a lack of support of its infrastructure. After preparation, the remaining structure had a thin layer of ceramic, especially on the gingival margin, so we decided to use a metal-ceramic crown. With this option we aimed to a more resistant structure that brought a correct support to the ceramic layer in the cervical and incisal areas.

Impression was made with a double mix technic using addition silicone (*Express light Body; 3M ESPE, St. Paul MN, USA* and *Express Penta H Putty Soft; 3M ESPE, St. Paul MN, USA*), followed by provisionally composite crown (*Structur Premium; Voco, Cuxhaven, Alemanha*). The provisional crown was cemented on the bridge with zinc phosphate cement (*DeTrey Zinc; Dentsply, Konstanz, Germany*), as it is shown in Fig.7.

On this case, the interface was mainly done by metal-alloy, so the definitive cementation was done using an adhesive resin with MDP (*Panavia F2.0, Kuraray, Kurashiki, Okayama, Japan*). The following protocol was used:

- Blast the both surfaces with 50 μ aluminium oxide for 5 seconds;
- Placement of an alloy primer (*Alloy Primer, Kururay, Kurasjiki, Okayama, Japan*) on the surfaces and let it evaporate;
- Application of the cement on the inner surface of the crown;
- Removal of excesses.

The final result is shown in Fig.8.

Fig.5 Restoration with a composite material

Fig.6 Preparation

Fig.7 Provisionally composite crown

Fig.8 Final result with metal-ceramic crown

Case 3

A 60-year-old female suffered a ceramic fracture of a lower metal-ceramic bridge of 12 elements (46 to 36) over implants. The fracture involved the region of the tooth 44, which was one of the retainers of this rehabilitation placed 5 years before. It involved the vestibular and occlusal areas exposing the metallic infrastructure (Fig.9). The coating ceramic was too thin and it could have been the main cause of the fracture.

On this case, since it was a screwed prosthesis, we could have the advantage of removing it and repair it on laboratory. Nevertheless, this solution did not seem to be the most suitable to the coating ceramic. The leucite (crystalline phase) of the coating ceramic is not stable after multiple fires (on a furnace), presenting a high risk of developing other fractures and/or altering aesthetic qualities of the ceramic (McLaren, 2003). These risk factors may force to substitute all of the coating ceramic, involving new trial phases and difficulty on obtaining the same final aesthetic and occlusal scheme.

Preparation of the affected area to apply an indirect technic over the bridge presented a more safe and less time consuming option. This would also not imply a complete provisional phosthesis and would solve the thickness problem.

Therefore, we prepared totally the vestibular and the occlusal surfaces of the tooth 44 and made a laboratory all-ceramic partial crown with an infrastructure of zirconia

(Fig.10). We chose this material because the area to rehabilitate was subjected to strong occlusal forces and the zirconia opacity will disguise the metal underneath.

Impression was made with a double mix technic using addition silicone (*Express light Body; 3M ESPE, St. Paul MN, USA* and *Express Penta H Putty Soft; 3M ESPE, St. Paul MN, USA*), followed by provisionally direct composite restoration (*Filtek Supreme; 3M ESPE, St. Paul MN, USA*), as it is shown in Fig.11.

The bonding of the parcial crown was done with an auto-adhesive resin cement (*Maxcem Elite; Kerr, Orange, CA, USA*), using the following protocol:

- Cleaning of both surfaces with orthophosphoric acid (*Total Etch; Ivoclar Vivadent, Schaan, Liechtenstein)*;
- Wash and dry;
- Application of the resin on the inner surface of the partial crown;
- Placement of the partial crown with digital pressure;
- Pre-polymerization (*Elipar™ S10 3M ESPE*) on vestibular and occlusal surfaces for 3-5 seconds;
- Removal of excess;
- Final polymerization for 10 seconds.

The final result is shown in Fig.12.

Fig.9 Ceramic fracture

Fig.10 Preparation

Fig.11 Provisionally composite crown

Fig.12 Final result with a ceramic partial crown

DISCUSSION

The repair of metal-ceramic bridges can be done using indirect technics with ceramic or metal-ceramic restorations. These technics present better and more predictable results when compared with direct technics based on composite restoration (Dent, 1979).

Yet, when we need to choose the cementation material some doubts can arise. Several different surfaces can be involved (metal and several ceramic materials) and it is rare to involve dental structures, such as dentine or enamel, or abutment materials like composite. Adhesive resistance is crucial because the mechanic retention is generally low. The appropriate material to bond the restoration on the remaining structure should be a resin-based cement. This type of cement presents the highest value of adhesive resistance (Blatz, 2003; Hill, 2011).

On the first case, the remaining surface after preparation was mostly ceramic, so a veneer with a medium opacity like lithium disilicate was chosen. This material permits a better aesthetic result with an inferior thickness when compared to other options involving metal or zirconia. Since a small area of metal was visible a more translucency veneer, like a feldspathic, would create difficulties on matching the colour. Thereby the interfaces to bond involved two different silica-based ceramics.

The second case presented a metal surface, which had to be totally opacified, so a veneer with an infrastructure of zirconia or metal was needed. We chose a metal infrastructure that also permitted a correct support for the ceramic with a thinner dimension when compared to zirconia. Consequently, both surfaces to bond were metallic.

The third case was similar to the second one regarding the surfaces, but with a larger thickness available. Since an abutment screw would be present underneath the new overlaying crown, a zirconia infrastructure would permit an easier access, if needed, due to colour contrasts and different consistencies. Thus surfaces to bond were metal and zirconia.

The answer on which cement should we chose must be based on different criteria. Several systems of resin cements with different protocols are available. Not only the chemical formula or the adhesive resistance matter, also clinical factors, such as the type of interfaces and ability to create and control isolation are important.

In the first case we chose an *Etch and Rinse* resin cement, because the clinical case allowed a good isolation, it was a frontal area of the mouth and a silica-based ceramic interface was present. The used protocol of bonding with hydrofluoric acid (micromechanical adhesion) and silane (chemical adhesion) has the highest bond strength values (Brentel, 2007; Calamia, 1983; Kumbuloglu, 2005). In the second clinical case, with two metal surfaces involved also in an anterior area, we chose a *Self etch* resin cement. This adhesive cement with phosphate monomers has an excellent capacity to bond polarized surfaces, as evidenced by several studies (Ertugrul, 2005; Tjan, 1992). Lastly, in the third clinical situation a good adhesive strength but with a simpler protocol was needed. The affected area was hard to isolate, so we chose auto-adhesive resin cement with phosphate monomers that permits to establish chemical bonds with the polarized surfaces (Burke, 2006). Different types of resin cements were used on the presented cases according to their characteristics.

CONCLUSION

The indirect repair technics of metal-ceramic bridges present better and more stable results than the direct restorations with composites (Bruggers, 1979; Cardoso, 1994; Dent, 1979; Quarnstrom, 2003; Welsh, 1997). However, there can be some doubts regarding the bonding system, due to the different materials involved on this interface. When the fracture is localized in an oral area that allows a complete control, the bonding option should be on the cement with higher adhesive resistance, like *Etch and Rinse* (Brentel, 2007; Calamia, 1983; Kumbuloglu, 2005). Yet, in areas where access is not so easy, cements with simpler protocols may be more suitable (Burke, 2006).

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